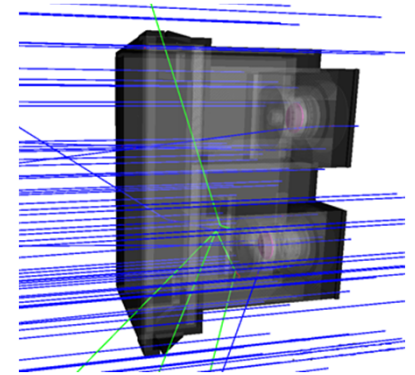


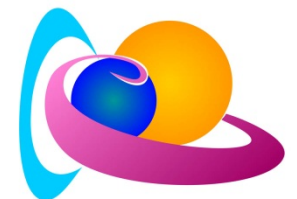
9th Geant4 Space Users' Workshop
Barcelona, March 4-6, 2013

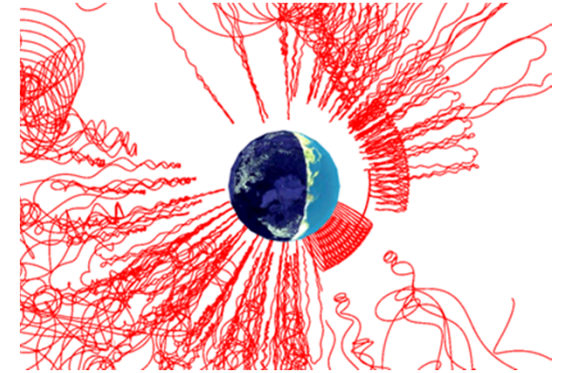


SPENVIS interface to Geant4-based tools

N. Messios , L. Hetey, S. Calders, E. de Donder, M. Kruglanski
Belgian Institute for Space Aeronomy (BIRA-IASB)

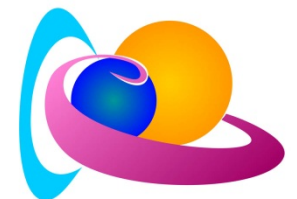
H. Evans
ESA Space Environments & Effects (ESTEC/TEC-EES)





Outline

- SPENVIS and its legacy
- Geant4 tools in SPENVIS
- The future of SPENVIS – SPENVIS-NG
- Interaction with users & developers
- Current and future developments



SPENVIS and its legacy

- ESA operational software (developed and maintained at BIRA-IASB since 1996)

<http://www.spenvis.oma.be/>

- Standardized access to most of the recent models of the hazardous space environment and effect tools
- On-line help and extensive background information

Geant4 tools in the SPENVIS environment

The following table gives an overview of the various [Geant4](#) tools available in SPENVIS.

Tool name	Version (Geant4 version)	Home page
MULASSIS	V1.19 (4.9.2)	http://reat.space.qinetiq.com/mulassis/
GEMAT	V2.4 (4.9.0)	http://reat.space.qinetiq.com/gemat/
SSAT	V2.1 (4.9.0)	http://reat.space.qinetiq.com/ssat/
MAGNETOCOSMICS	V2.0 (4.7.1)	http://cosray.unibe.ch/~laurent/magnetocosmics/
PLANETOCOSMICS	V2.0 (4.8.1)	http://cosray.unibe.ch/~laurent/planetocosmics/
GRAS	V2.3 (4.9.2)	http://space-env.esa.int/index.php/geant4-radiation-analysis-for-space.html

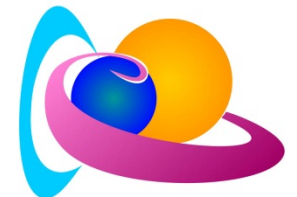
The SPENVIS interface of all these tools simplifies the process of defining run parameters using a number of input pages (see the detailed tool help pages for more information).

Advanced users have the option to input a number of fine-tuning parameters.

The [Geant4](#) tools use a Monte-Carlo simulation-based code and execution times can be very long. In order to guarantee the consistency between the different models available in the SPENVIS system (e.g. particle spectrum vs. total ionising dose), the user project is 'blocked' while running any simulation. However, navigation remains possible. The execution is limited to ten minutes of CPU-time on the simulation machine. If the application run exceeds this limit, the simulation will be terminated and intermediate results returned to the user.

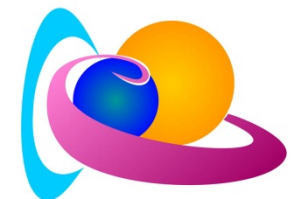
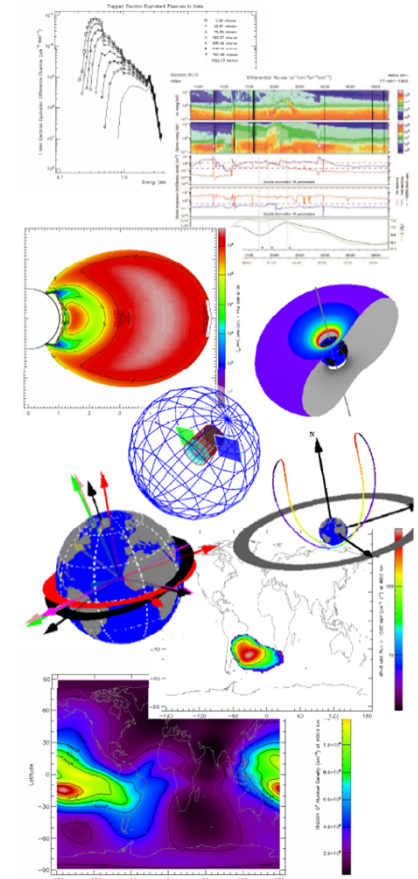
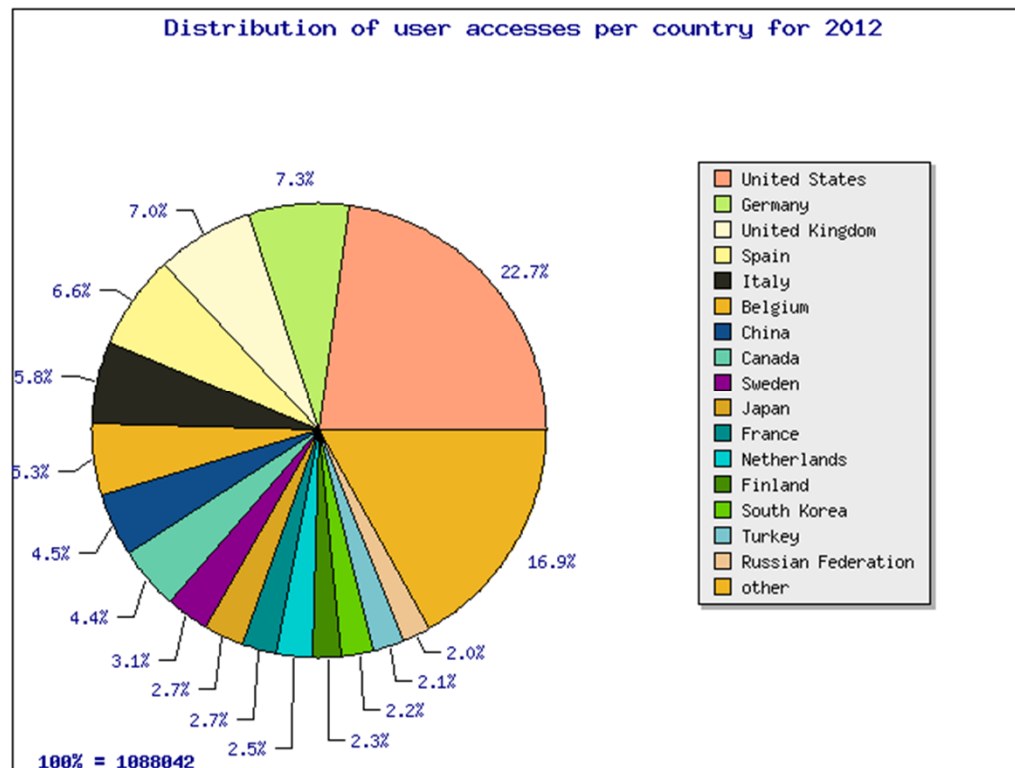
References

1. [QinetiQ website](#)
2. [Geant4 website](#)
3. [Geant4 Space Users Page](#)
4. [Geant4 Physics Reference Manual](#)



Who is using SPENVIS?

- Spacecraft or component designers
- University or college students
- Scientists & model developers



Geant4 tools in SPENVIS


- User friendly interface
- No prior knowledge of Geant4
- Generated macro file can be used directly by local Geant4 application
- Interaction with other SPENVIS models & tools



The screenshot shows the SPENVIS Project: G4SUW9 interface. At the top, there is a dark blue header bar with the text "SPENVIS Project: G4SUW9", "Model packages", and "Planet: Earth". On the left side of the header bar is an "UP" button, and on the right side are "Output" and "Help" buttons. Below the header bar is a list of model packages, each in a dark blue box with white text. The packages are: "Coordinate generators", "Radiation sources and effects", "Spacecraft charging", "Atmosphere and ionosphere", "Magnetic field", "Meteoroids and debris", "Miscellaneous", and "Geant4 Tools". Below "Geant4 Tools" is a section titled "General models" with links to "Multi-Layered Shielding Simulation (Mulassis)", "Geant4 Radiation Analysis for Space (GRAS)", "Geant4-based Microdosimetry Analysis Tool (GEMAT)", and "Sector Shielding Analysis Tool (SSAT)". Below this is a section titled "Planet specific models" with links to "Magnetocosmics" and "Planetocosmics". Below that is a section titled "Common settings" with links to "Definition of source particles", "Definition of physics models", "User defined materials", and "Geometry definition tool". At the bottom of the list is "ECSS Space Environment Standard".

The models implemented in SPENVIS are combined in the packages listed above. Clicking on a package name will expand the table with a list of models. Some model suites have to be executed in a prescribed order. Model links will not be available when pre-required runs have not been executed yet. Most models run on both a spacecraft trajectory and a geographical coordinate grid. Clicking on the coordinate generator links and returning to this page toggles between the two sets of coordinates. The model links will adapt to the choice of coordinates.



Geant4 model interface in SPENVIS



SPENVIS Project: G4SUW9
Geant4 tools
 Geant4 Radiation Analysis for Space (GRAS)

GRAS is a Geant4-based tool that provides a general space radiation analysis for 3D geometry models. GRAS is a complex tool, so please consult the help page before using it.

GRAS execution mode: GDML <input type="button" value="v"/>		
Status	Settings	
defined	Source particles	Trapped, proton
defined	Source geometry	GDML, particle tracks
defined	Analysis parameters	Fluence
Advanced settings		
defined	GDML definition	upl, GDML file analysis
default	Region cuts-in-range	---
defined	Physics models	Standard EM, Hadron

Model developed by



Source particle type and spectrum

Environment: Mission based trapped particles

Number of primary particles to simulate: 100

Incident particle type: proton

Incident energy spectrum

Mission average spectrum

Don't use energy biasing

Interpolation type: linear

Analysis type: Total ionizing dose

- Fluence
- Non ionising energy loss
- Total ionizing dose**
- Dose equivalent analysis
- Equivalent dose

Output units: r

Select 2 vol

Volume 1: Layer_1 (G4_Al)

Volume 2: Layer_2 (G4_Si)

Source geometry

Length units: [mm]

Centered at: world

x: 0 y: 0 z: 100

Type: disk radius: 20

Pointing to:

- point
- disk**
- sphere

x: U y: 0 z: 0

Visualisation

Format: Virtual Reality Modelling Language (VRML)

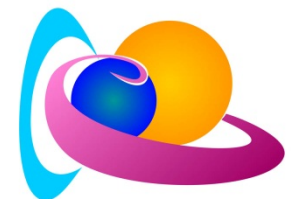
Particle tracks: Display

© ESA



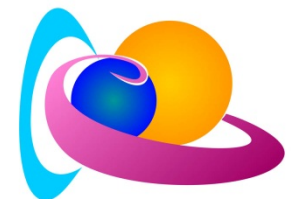
Overview of the Geant4 tools in SPENVIS

- Geant4 Radiation Analysis for Space (GRAS v2.3, v3.1)
 - General space radiation analysis for 3D geometry models (Fluence, NIEL, TID, Dose equivalent and Equivalent dose analysis)
 - Developed by ESA
- Multi-Layered Shielding Simulation (MULASSIS v1.19, v1.23)
 - Definition of a multi-layered, one-dimensional shield and incident particle source
 - Simulates radiation transport through the geometry, treating electromagnetic and nuclear interactions
 - Developed by QinetiQ
- Geant4-based Microdosimetry Analysis Tool (GEMAT v2.4, v2.8)
 - Microdosimetry effects of space radiation on micro-electronics and micro-sensors
 - Developed by QinetiQ



Overview of the Geant4 tools in SPENVIS

- Sector Shielding Analysis Tool (SSAT v2.1)
 - Performs ray tracing from a user defined point within the geometry to determine shielding levels and shielding distributions
 - Shielding distributions can be folded with flux and dose models (e.g. from SHIELDOSE or NIEL)
 - Developed by QinetiQ
- MAGNETOCOSMICS (v2.0)
 - Charged particle trajectories & magnetic field lines
 - Cut-off rigidities as a function of position
 - Developed at the University of Bern
- PLANETOCOSMICS (v2.0)
 - Definition of a planetary magnetic field, atmosphere & soil
 - Interactions of cosmic rays with planetary environment
 - Developed at the University of Bern

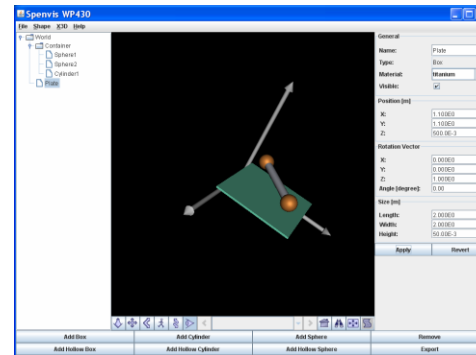


Overview of the Geant4 tools in SPENVIS

- Supporting Tools

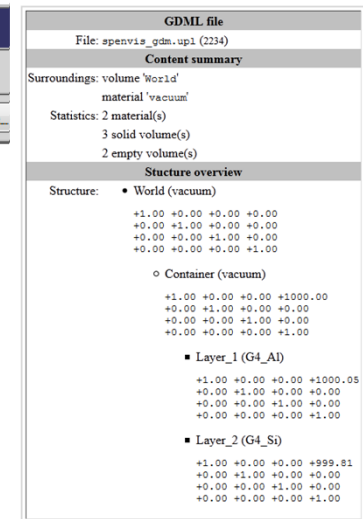
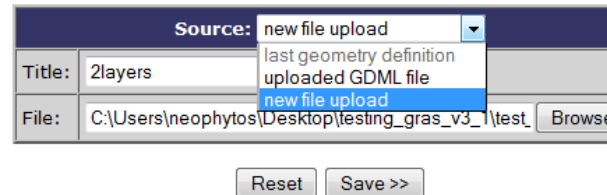
- Geometry definition tool

- Basic building blocks (sphere, box, cylinder) to construct 3D model
 - Java Geometry Definition Tool (JGDT)



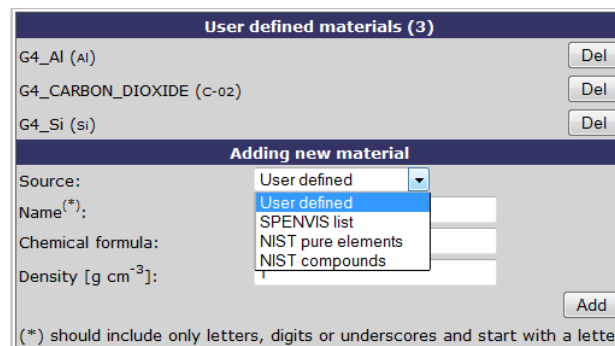
- GDML analysis tool

- Use generated GDML file
 - Upload new file



- Material definition tool

- Define own material or choose from predefined lists
 - Material available for all Geant4 applications in SPENVIS



Reset Save >>



Overview of the Geant4 tools in SPENVIS

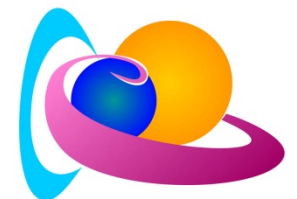
- Other:
 - Mars Energetic Radiation Environment Models (MEREM)



- Jupiter Radiation Environment and Effects Models and Mitigation (JOREM)
 - PLANETOCOSMICS-J
 - Genetic Algorithm Radiation Shield Optimiser (GARSO) for MULASSIS



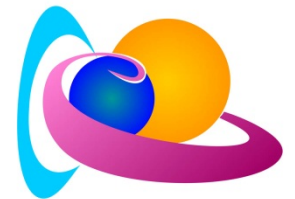
- MC-SCREAM (NIEL based damage equivalent fluences for solar cells)



Why a new SPENVIS system?

Drawbacks of current SPENVIS:

- Rigid work flow for model access and no flexibility in model coupling
- Not easy plug-in of new models by model developers
- Splitting between orbital and positional models
- Import of user data
- Lack of advanced access (machine-to-machine)



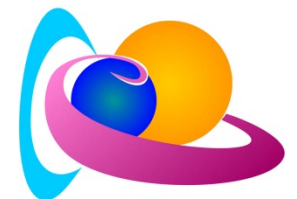
SPENVIS Next Generation (SPENVIS-5)

Upgrade the current SPENVIS system into a new web-based service-oriented distributed framework

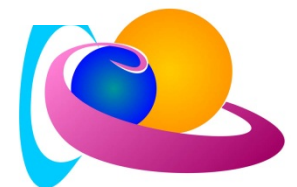
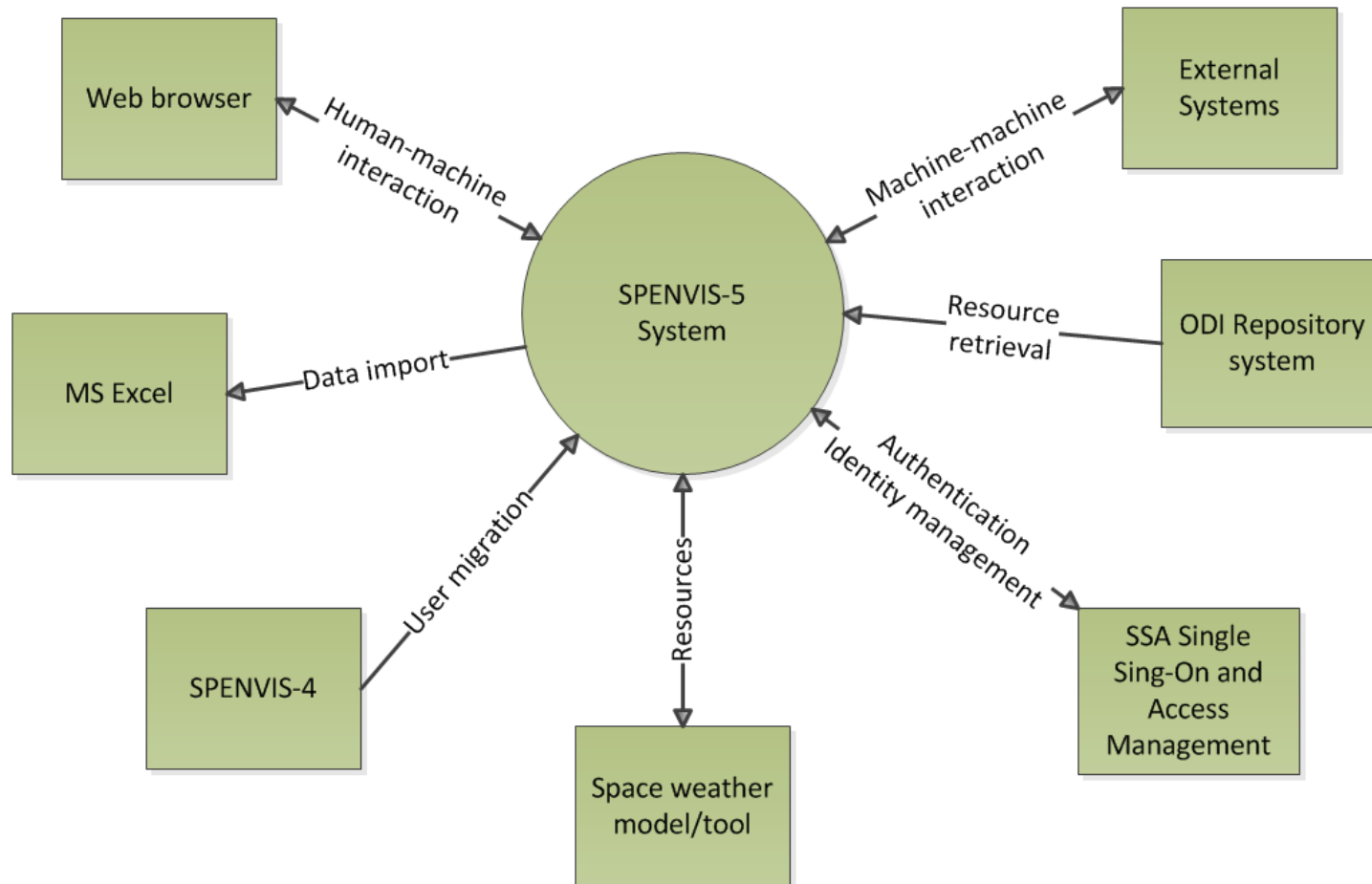
- Plug-in support of models
- User-friendly interface for rapid analysis
- Machine-to-machine interface for interoperability with other software tools



ESTEC Contract 4000104812



SPENVIS-NG external environment

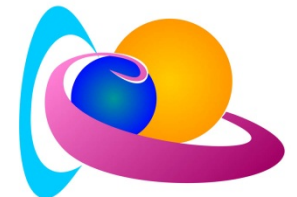


SPENVIS-NG workflows

The screenshot shows a web browser window displaying the SPENVIS-NG interface. The browser address bar shows a URL starting with 'http://...'. The page has a header with 'Test NG' and a date/time 'DD/MM/YYYY 00:00:00'. Below the header is a menu with 'Home > View existing projects > Test NG'. The main content area is titled 'Existing workflows' and contains a table with columns: Workflow, status, results, share, and Delete. The table lists three workflows: Workflow 1 (running), Workflow 2 (aborted), and Workflow 3 (ready). Annotations include 'Click to modify or execute' pointing to the 'Workflow 1' row, 'Click to open results view' pointing to the 'results' column, and 'Workflow creation wizard' pointing to a 'Create new workflow' button. A 'Leads to' arrow points from the 'Create new workflow' button to a 'Workflow creation wizard' box. The wizard box contains sections for 'Input Resources' and 'Output Resources', each with two resource entries and a 'Save' button. Below the wizard are 'Run' and 'Stop' buttons. The page also features a sidebar with navigation options like 'My account', 'My projects', 'Development', and 'Site information'.

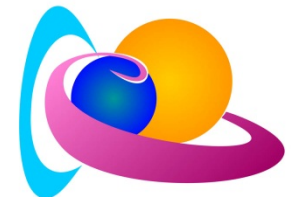
Workflow	status	results	share	Delete
Workflow 1	running		↕	×
Workflow 2	aborted		↕	×
Workflow 3	ready		↕	×

- Combine models & tools in workflows
 - Predefined scenarios
 - User own workflows
- Tune the user interface of models
 - Fixing in advance some parameters
 - Hiding some intermediate resources
 - Re-grouping differently the input fields



Software Development Kit (SDK)

- To allow model developer to plug their models
- Should contain:
 - An easily installable local environment so developers can test the operation of new models and tools
 - Tools for wrapping models and for generating input & output adapters
 - Tools for creating data format adapters
 - Tools for generating default UI components
- Provide documentation on
 - How to install the local environment
 - General documentation on the SPENVIS-NG system
- Tutorial + simple test model for integration in SPENVIS



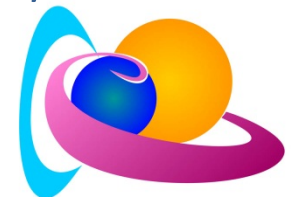
Geant4 Tools in SPENVIS-NG

The ESA Geant4 radiation effects applications, which include MULASSIS, GEMAT, GRAS and SSAT, are under continual development both as Geant4 is updated and to provide additional functionality. The user interfaces to these tools in SPENVIS-5 shall be updated to include the new functionality and changes to the interfaces of these tools. New functionality may include (but not be limited to) **changes to the physics lists, new analysis modules, new geometry description methods, and new output formats**. The SPENVIS-5 interfaces to these tools shall be updated to make use of the recent developments in the Geant4 **reverse Monte-Carlo** physics.

STATEMENT OF WORK

Next Generation SPENVIS

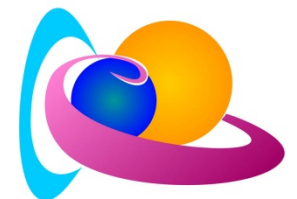
TEC-EES/2010.666/HE



Geant4 Tools in SPENVIS-NG

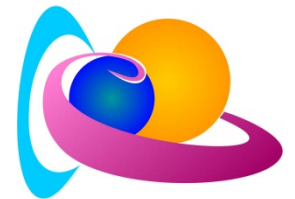
A module to export the radiation environment spectra as Geant4/GPS particle source spectra macro files shall be implemented

- All environments shall be included
 - trapped particle
 - solar proton
 - galactic cosmic ray
- The module outputs shall support the specification of
 - multiple sources
 - normalisation factors
 - energy biasing



New models in SPENVIS-NG

- ESA MEO model implementation
- ESA Interplanetary Electron Model (IEM)
- ESA Slot Region Radiation Environment Model (SRREM)
- Updates to JOREM Radiation Environment Model
- Interface to ESA SEPTEM solar proton models & integration with SEPTEM system
- Badwar & O’Niel cosmic ray model
- NASA AE-9 & AP-9 models
- NASA TPM model



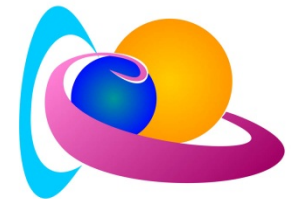
How could you play a part?

- SPENVIS forum
Interaction between users & model developers
- Contact us directly
spenvis_team@aeronomie.be
- SPENVIS workshops

TOPICS	REPLIES	VIEWS	LAST POST
SSAT Sector angles and weighting to poles by alexlyne on Tue Jan 29, 2013 1:52 pm	0	6	by alexlyne G on Tue Jan 29, 2013 1:52 pm
GRAS by kpf123 on Thu Dec 13, 2012 2:10 pm	1	22	by messios G on Mon Dec 17, 2012 10:03 am
MULASSIS:about the analysis of fluence by hupenfang on Wed Nov 07, 2012 8:35 am	1	25	by messios G on Mon Nov 19, 2012 10:39 am
Mulassis: Using mixtures as material by marfonero on Sat Nov 03, 2012 2:46 am	1	19	by messios G on Mon Nov 05, 2012 12:47 pm
SPENVIS vs local GRAS output by banister on Sat Aug 11, 2012 1:07 pm	2	50	by wolfgang_mai G on Thu Sep 27, 2012 8:33 am
MULASSIS layer definition in .csv output by fridaape on Wed Aug 15, 2012 11:52 pm	2	36	by fridaape G on Thu Aug 16, 2012 7:02 pm
dose spectrum by kpf123 on Sun Aug 12, 2012 2:57 am	3	43	by messios G on Thu Aug 16, 2012 9:30 am
NIEL calculation in GRAS by banister on Fri Aug 03, 2012 4:48 pm	2	51	by banister G on Wed Aug 08, 2012 7:58 am
Mulassis: Probable Bug by Bessyl on Thu Jun 28, 2012 12:25 pm	3	53	by messios G on Mon Aug 06, 2012 12:55 pm
GMXL Geometry in GRAS by kpf123 on Tue Jul 31, 2012 5:09 am	3	47	by kpf123 G on Wed Aug 01, 2012 3:10 pm
physics scenario by kpf123 on Thu Jul 19, 2012 1:51 am	2	35	by kpf123 G on Tue Jul 31, 2012 5:01 am
MULASSIS TID calculation by messios on Mon Jul 09, 2012 8:24 am	0	31	by messios G on Mon Jul 09, 2012 8:24 am
GRAS ERROR by kpf123 on Thu May 10, 2012 3:08 pm	3	54	by messios G on Wed May 30, 2012 3:59 pm
Mulassis - material definition by olkar on Tue May 08, 2012 4:56 pm	0	30	by olkar G on Tue May 08, 2012 4:56 pm
fluence_flux_number Tary particles to simulate by rossi on Tue Apr 24, 2012 7:25 am	1	38	by messios G on Wed Apr 25, 2012 2:22 pm

Category	Severity	Status	Updated	Summary
[SPENVIS] Package: Geant4 tools	major	new	2013-01-17	SSAT 4
[SPENVIS] Add-on: Development Tools	minor	feedback	2012-11-27	MC-SCREAM
[SPENVIS] Package: Geant4 tools	major	resolved (Laszlo Hetey)	2012-11-21	Geometry definition tool and SSAT use opposite rotation vector polarity
[SPENVIS] Package: Geant4 tools	major	resolved (Laszlo Hetey)	2012-11-21	<PHYSVOL> tags must have a "NAME=" attribute included
[SPENVIS] Package: Magnetic Field	major	feedback (Michel Kruglanski)	2012-11-06	Trapped particle models on magnetic coordinate grids BUG on Flux Map using B as second coordinate
[SPENVIS] Package: Single Event Effects	major	resolved (Erwin De Donder)	2012-10-17	Error reading spectrum file (EOF)
[SPENVIS] Packages: Spacecraft Charging	minor	resolved	2012-10-16	Display Used Conductivity with Dictate
[SPENVIS] Package: Radiation Sources	major	resolved	2012-09-10	Anisotropy model altitude validity range should be imposed and documented
[SPENVIS] Package: Geant4 tools	major	resolved	2012-09-10	Incorrect use of ISO in /gps/ang/type macro when environmental spectra is specified
[SPENVIS] Package: Meteoroids and Debris	major	resolved	2012-09-05	Large difference in MMOD fluence between GRDEM2000 and MASTER2009
[SPENVIS] Package: Geant4 tools	major	feedback (Neophytos Messios)	2012-08-13	Mulassis bug: No planar e- flux through boundary 3

Feedback is always welcome!!!!





SPENVIS User Workshop 2013 Brussels, Belgium 22 - 24 May 2013

Steering Committee: M. Kruglanski (BIRA/IASB), H. Evans (ESA/ESTEC), E. Daly (ESA/ESTEC), D. Rodgers (ESA/ESTEC)

The SPENVIS User Workshop will be held at the Royal Library of Belgium, Belgium's national and scientific library. It is one of the most important libraries in Europe since its history goes back to the 15th century. It is located in the heart of Brussels at walking distance from the Central Railway Station.



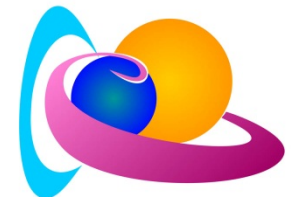
<http://www.spennis.oma.be/workshop/2013/>

Workshop Goal

The main objective of this event is to bring the SPENVIS users together to share their experience and to identify their requirements. The workshop will focus on the current and the forthcoming Next Generation SPENVIS systems.

Topics include:

- Current and future SPENVIS overview
- Space Radiation Models and their accuracy
- Space Environment Effects (charging, SEE, degradation, micro-particle impacts)
- Geant4 Tools
- Educational use of SPENVIS
- SPENVIS and other tools



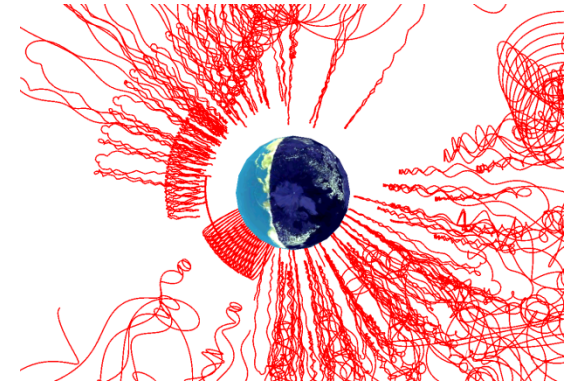
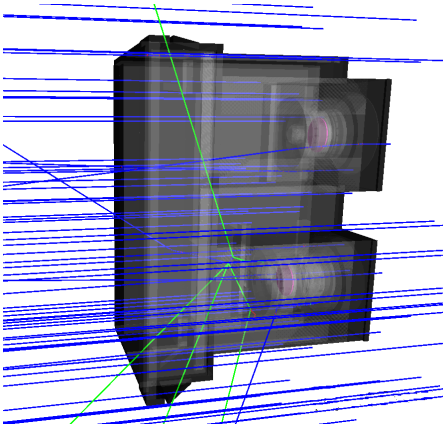
Current and future developments

- SPENVIS maintenance
 - Implementation of GRAS v3.1, MULASSIS v1.23 & GEMAT v2.8 (Geant4-9.5p2)
 - GDML analysis tool update
 - Support the users community
- Development of SPENVIS-NG
 - Existing & new models
 - New functionalities (plug-in models, machine-machine interface etc.)
- Acknowledgement
 - Model & data providers
 - The SPENVIS-NG team:
Michel Kruglanski, Laszlo Hetey, Erwin De Donder, Neophytos Messios, Stijn Calders, Bernard Fontaine, Nicolae Mihalache, Martin Ursik, Esther Parrilla-Endrino, Angela Rivera Campos, Pablo Beltrami, Ralf Keil & Daniel Heynderickx

Tables	Plots
Log file for the Geant4 analysis for space tool v2.3	VRML representation of the geometry (GRAS 2.3)
Log file for the Geant4 analysis for space tool v3.1	Output preview of GRAS v2.3 results (PS)
Output root file for the Geant4 analysis for space tool v2.3	Output preview of GRAS v3.1 results (PS)
Macro file for the Geant4 analysis for space tool v2.3	VRML representation of the geometry (GRAS 3.1)
Output csv file for the Geant4 analysis for space tool v2.3	
GDML file analysis	
Macro file for the Geant4 analysis for space tool v3.1	
Output root file for the Geant4 analysis for space tool v3.1	
Output csv file for the Geant4 analysis for space tool v3.1	

The current SPENVIS implementation is running the version 2.3 of GRAS (based on Geant4-9.2p1). The button "Try v3.1" allows testing the version 3.1 of GRAS (Geant4-9.5p2) using the same macro file.





THANK YOU!

